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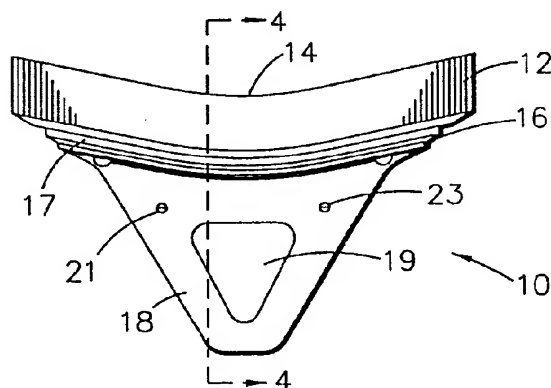
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(54) **Anatomic glenoid shoulder prosthesis together with methods and tools for implanting same**

(57) A glenoid component 10 includes an oval body 12 having a concave lateral articulating surface 14 and an opposing medial surface 16 with a keel 18 extending from the medial surface. The keel 18 extends along a line "A" which is anteriorly offset from the center line "B" of the concave surface 14 and is not collinear with any radius of the concave surface 14. New methods and tools are provided for the implantation of the glenoid component. Sizer drill guides 20 are provided with an alignment arm 28 which assures that the anterior/posterior angle of the pilot hole is approximately 65 degrees.

An improved reamer tool 40 is provided which allows the practitioner to attach a reamer head 54 of selected size to the reamer rather than choosing among several reamers of different size at the time of the procedure. A new keel drill guide 70 is provided which locates three drill guide holes 73,75,77 in a plane which is offset approximately 2mm anterior of the pilot hole. A new broach tool 80 is provided for connecting the three holes and form a triangular or trapezoidal cavity for the keel. Methods for installing the glenoid component and using the tools are also disclosed.



**FIG. 2**

## Description

### Field of the Invention

[0001] The invention relates to a glenoid component for a shoulder prosthesis. More particularly, the invention relates to a glenoid component having a long off-axis keel and methods and tools for implanting the glenoid component.

### Description of the Related Art

[0002] The human shoulder joint includes two major components, the glenoid component and the humeral component. The glenoid component is the portion of the scapula which forms a socket-like structure for the humeral component. The humeral component is the upper end of the upper arm which forms a ball-like structure which fits into the glenoid component.

[0003] Prosthetic shoulder joints are well known in the art and many different glenoid and humeral components have been provided. Various methods and tools have also been provided for implanting a prosthetic glenoid component. A typical state-of-the-art glenoid component is disclosed in U.S. Patent Number 5,489,310 to Mikhail which also discloses methods and tools for implanting the component.

[0004] The typical glenoid component includes a circular body having a concave lateral articulating surface and an opposing medial surface with a stem extending along a central axis from the medial surface. The glenoid component is installed after the scapula is resected to remove the natural glenoid and a cavity is formed in the neck of the scapula to receive the prosthetic glenoid component.

[0005] The methods and tools described in the '310 patent are designed to permit installation of the glenoid component with a minimal amount of bone removal required in the preparation of the scapula. Utilizing the methods and tools of the '310 patent, different sizer guides are used to measure the size of the natural glenoid cavity in order to choose a prosthetic component of proper size through trial and error. The sizer guides each have a plurality of pointed members and a central hole. After the proper size has been determined, the corresponding sizer guide is hammered into the bone of the scapula and the central hole in the sizer guide is used as a drill guide to drill a 15-30mm hole in the scapula.

[0006] A reamer of appropriate size is then chosen based on the size of the sizer guide previously chosen. The reamer has a symmetrical head with a plurality of tapered cutting blades and a peripheral stop surface. The previously drilled hole is used as a center guide for the reamer. The reamer is used to create a cavity in the scapula in which the prosthetic glenoid component will be installed. After the cavity has been created, the circular glenoid component is installed in the cavity, with or without the use of bone cement.

[0007] Despite the numerous advances in the designs of glenoid components and the methods and tools used for their installation, these prostheses still lack the stability and strength of natural healthy glenoid components and the relative positions of the prosthetic glenoid and humeral components most often does not provide the proper soft tissue balance.

### SUMMARY OF THE INVENTION

[0008] It is therefore an object of the invention to provide a prosthetic glenoid component which more accurately copies the function of a natural glenoid component.

[0009] It is also an object of the invention to provide prosthetic glenoid component which is more stable than existing prosthetic glenoid components.

[0010] It is another object of the invention to provide a prosthetic glenoid component which, when implanted, provides proper soft tissue balance between the glenoid component and the humeral component.

[0011] It is still another object of the invention to provide a glenoid component and methods and tools for its installation which achieve the aforementioned objects and which minimize the risk of damage to the posterior scapula.

[0012] In accord with these objects which will be discussed in detail below, the glenoid component of the present invention includes an oval body having a concave lateral articulating surface and an opposing medial surface with a keel extending from the medial surface.

[0013] According to one aspect of the invention, the keel extends along a line which is anteriorly offset from the center line of the concave surface and is not collinear with any radius of the concave surface.

[0014] According to another aspect of the invention, the keel is substantially triangular or trapezoidal in shape and functions like an I-beam to provide greater support for the glenoid component when attached to the scapula.

[0015] According to a presently preferred embodiment, the medial surface of the glenoid component has ridges and the keel has a central hole, both of which enhance fixation of the component to the scapula.

[0016] The design of the glenoid component of the invention is based in part on the observation that the centerline of a natural glenoid component is not collinear with the centerline of scapula bone mass. It was thus hypothesized that the symmetrical glenoid components with central stems and the methods and tools for their installation result in the affixation of the component to a portion of the scapula which has reduced bone mass. It is believed that this is the cause of reduced stability, damage to the posterior scapula, and imbalance in the soft tissues between the glenoid and humeral components.

[0017] According to further aspects of the invention, new methods and tools are provided for the implantation

of the novel glenoid component. In particular, sizer drill guides are provided with an additional alignment arm which assures that the anterior/posterior angle of the pilot hole is approximately 65 degrees. This angle was discovered to be the optimal angle in a series of unpublished cadaver studies.

**[0018]** According to other aspects of the invention, an improved reamer tool is provided which allows the practitioner to attach a reamer head of selected size to the reamer rather than choosing among several reamers of different size at the time of the procedure.

**[0019]** In order to provide the proper hole in the scapula for the keel of the glenoid, a new keel drill guide is provided which locates three drill guide holes in a plane which is offset approximately 2mm anterior of the pilot hole. One of the drill guide holes is a central hole and the other two holes parallel therewith. A new broach tool is provided for connecting the three holes and forming a triangular cavity for the keel.

**[0020]** The methods of installation according to the invention include selecting the appropriate sizer drill guide in a conventional way, using the sizer drill guide of the invention to drill a pilot hole in the center of the glenoid, but with an A/P angle of approximately 65 degrees, using the new glenoid reamer to resect the glenoid cavity around the pilot hole, using the new keel drill guide to drill three holes which have axes aligned in a plane which is anteriorly offset from the pilot hole, and using broach tool to connect the three holes and form a triangular cavity for the keel. The glenoid component is then installed with bone cement and is placed to tilt slightly downward (up to approximately 5 degrees) in order to reduce superior migration of the humeral head.

**[0021]** Additional objects and advantages of the invention will become apparent to those skilled in the art upon reference to the detailed description taken in conjunction with the provided figures.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### **[0022]**

FIG. 1 is an anterior-posterior side elevational view of a glenoid component according to the invention;  
 FIG. 2 is a posterior side elevational view of the glenoid component of FIG. 1 ;  
 FIG. 3 is a perspective view of the glenoid component of FIG. 1 ;  
 FIG. 4 is a cross section taken along line 4-4 in FIG. 2;  
 FIG. 5 is a posterior side elevational view of a component of the pilot guide according to the invention;  
 FIG. 6 is a (superior or inferior) side elevational view of the component of FIG. 5;  
 FIG. 7 is a perspective view of the component of FIGS. 5 and 6;  
 FIG. 8 is a (superior or inferior) side elevational view of the component of FIGS. 5-7 with the alignment

arm according to the invention attached to the component and showing the location of the pilot hole drill bit;

FIG. 9 is a perspective view of the assembly of FIG. 8;

FIG. 10 is a side elevational view of a reamer handle according to the invention;

FIG. 11 is a back side view of a reamer head according to the invention;

FIG. 12 is a front side view of the reamer head of FIG. 11 ;

FIG. 13 is a cross section taken along line 13-13 in FIG. 12;

FIG. 14 is a side elevational view of a tool for removably attaching the reamer head to the handle according to the invention;

FIG. 15 is a posterior side elevational view of the keel drill guide according to the invention;

FIG. 16 is a (superior or inferior) side elevational view of the drill guide of FIG. 15;

FIG. 17 is a perspective view of the drill guide of FIGS. 15 and 16;

FIG. 18 is a (superior or inferior) side elevational view of keel hole broach according to the invention; and

FIG. 19 is a perspective view of the broach of FIG. 18.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0023]** Referring now to FIGS. 1 through 4, a glenoid component 10 according to the invention includes an oval body 12 having a concave lateral articulating surface 14 and an opposing medial surface 16 with a keel 18 extending from the medial surface 16. According to one aspect of the invention, and as shown best in FIGS. 1 and 4, the keel 18 extends along a line "A" which is anteriorly offset from the center line "B" of the concave surface and is not collinear with any radius of the concave surface. For example, as shown in FIG. 4, the line "A", along which the keel 18 extends, does not intersect the center "C", from which the surface 14 is generated.

**[0024]** According to a presently preferred embodiment, the keel 18 is substantially triangular or trapezoidal in shape. The superior and inferior sides of the keel 18 taper substantially as shown in FIGS. 2 and 3. However, the anterior and posterior sides of the keel 18 also taper as shown in FIGS. 1 and 4. This design of the keel allows it to function like an I-beam to provide greater support for the glenoid component when attached to the scapula.

**[0025]** According to a presently preferred embodiment, the medial surface 16 of the glenoid component has ridges, e.g. 17, and the keel has a recessed pocket 19, both of which enhance fixation of the component to the scapula.

**[0026]** As seen in FIG. 2, the keel 18 is also advanta-

geously provided with a pair of small holes 21, 23 which are dimensioned to a radiopaque material such as radiopaque wires. The location of these holes relative to the geometry of the glenoid component 10 permits fluoroscopic examination of the superior-inferior version of the component during implantation. In other words, the location of the holes defines an axis which is parallel to the vertical axis of the component. Those skilled in the art will appreciate that the glenoid component is made in a variety of sizes for use with large and small patients. The relative overall dimensions of the component can be given for example as approximately 1.299 in the superior-inferior direction, approximately .945 in the anterior-posterior direction, and approximately .750 in the medial-lateral direction.

**[0027]** Referring now to FIGS. 5-9, a sizer drill guide 20 according to the invention includes handle portion 22 and a template head 24. The head and the handle are attached to each other at an angle of approximately 45 degrees such that when the drill guide 20 is in use, the handle extends anteriorly from the head. The head 24 has a central hole 25 which is dimensioned to receive a drill bit 26 (FIGS. 8 and 9) for drilling a pilot hole in the glenoid, prior to reaming.

**[0028]** Those skilled in the art will appreciate that the size of the head 24 is designed to correspond to the size of a glenoid component. Thus, as described in more detail below, the practitioner will use a number of sizer drill guides until the appropriate size is found.

**[0029]** According to the invention, the sizer drill guides are provided with an alignment arm 28 which assures that the anterior/posterior angle  $\alpha$  of the pilot hole is approximately 65 degrees.

**[0030]** According to a presently preferred embodiment, the arm 28 is removably attached to the handle 22 by a collar 30 and a set screw 32. In use, the arm is placed against the anterior scapula and this automatically angles the drill guide at 65 degrees.

**[0031]** Turning now to FIGS. 10-14, an improved reamer according to the invention includes a handle 40 with an angled head 42. The handle includes a drive shaft 44 which has a proximal coupling 46 for coupling it to a motor (not shown). The drive shaft is coupled at its distal end to a rotating tip 48. The tip 48 has a rounded distal end 50 and an intermediate threaded portion 52. A removable reaming tool 54 is a generally circular member having a central threaded bore 56, a reaming surface 58, and a plurality of angularly spaced apart through shots 60a-60f. The reaming tool 54 is made in a variety of sizes, each of which corresponds to a different size glenoid component. However, each of the reaming tools has the same sized central threaded bore 56 so that it may be attached to the threaded portion 52 of the tip 48 of the reamer handle 40.

**[0032]** According to the presently preferred embodiment, the reaming tools 54 each have six through slots which are evenly spaced apart. These slots serve two functions, to allow through passage of bone tissue as

the glenoid is being reamed, and to permit the rapid attachment of the tool 54 to the tip 48 using a special tool 62, shown in FIG. 14. The tool 62 has three slot engaging members 64a, 64c, 64e which extend downwardly from a circular base 66 and an upstanding T-handle 68 which extends from the other side of the base 66. The slot engaging members are dimensioned and angularly spaced apart to engage three of the six through slots in the tool 54.

**[0033]** Those skilled in the art will appreciate therefore, that the tool 54 is attached to the tip 48 by placing the threaded hole 56 over the tip 48 and spinning the tool 54 until the threads in the bore 56 engages the threads 52 on the tip 48. When the reaming tool 54 is so engaged, the tightening tool 62 is used to tighten the reaming tool 54 to the tip 48.

**[0034]** It will also be appreciated that the smooth end 50 of the tip 48 will extend beyond the surface 58 of the reaming tool 54. This portion of the tip will be used to locate the reamer relative to the pilot hole as described in more detail below.

**[0035]** Turning now to FIGS. 15-17, a keel drill guide 70 according to the invention includes a handle portion 72 and a drill template head 74. The template head 74 has a distally extending central guide post 76 and three holes 73, 75, 77 for receiving drill bits as described in more detail below. The overall size and shape of the template head 74 corresponds to the overall size and shape of the template head 24 of the sizer drill guide 20 described above.

**[0036]** Thus, it will be appreciated that the keel drill guide 70 is provided in different sizes corresponding to the different size glenoid components. The central guide post 76 is dimensioned to fit inside the pilot hole created with the sizer drill guide and the three holes 73, 75, 77 are arranged with their axes lying in a plane which is spaced apart from the axis of the guide post 76.

**[0037]** More particularly, as seen best in FIG. 16, the axes of the holes lie in a plane which is anteriorly spaced apart from the guide post 76. Those skilled in the art will appreciate that the anterior offset of the holes corresponds to the anterior offset (approximately 2mm) of the keel in the glenoid component. As seen best in FIG. 15, the axes of the two outer holes 73, 77 are angled relative to the middle hole 75.

**[0038]** It will be appreciated that after three holes in the scapula are drilled with the aid of the keel drill guide, the three holes will approximate the triangular hole required to receive the keel of the glenoid component. The walls between the three holes are cut with the aid of the broach tool, described below with reference to FIGS. 18 and 19 to form a triangular or trapezoidal cavity for the keel.

**[0039]** As shown in FIGS. 18 and 19, a broach tool 80 according to the invention includes a handle portion 82, a base portion 84, and a rasp 86 which extends downward from the base portion. The base portion is dimensioned to match the template portions of the drill guides

20 and 70 described above. Thus the broach tool 80 is provided in different sizes which correspond to the different size glenoid components. The rasp 86 is located and dimensioned to correspond to the keel of the corresponding glenoid component. Those skilled in the art will appreciate that the broach tool 80 is utilized by inserting the rasp into the middle hole created with the keel drill guide 70 and cuts through the wall of the middle hole into the side angled holes.

**[0040]** Referring now to all of the figures, the methods of implanting the glenoid component according to the invention include selecting the appropriate sizer drill guide (FIGS. 5-9) in a conventional way and using the sizer drill guide of the invention to drill a pilot hole in the center of the glenoid with an A/P angle of approximately 65 degrees. The drill guide should be in firm contact with the glenoid surface and neck. In cases of severe anterior-posterior version (pathological retro- or anteversion) some bone may need to be removed from either the anterior or posterior side of the glenoid with a high speed burr. The 65 degree angle and the use of a drill bit with a stop assures that the pilot hole does not perforate the anterior or posterior cortex.

**[0041]** Having selected a particular size for the drill guide shown in FIGS. 5-9, corresponding sizes will be used in the following steps. In particular, a corresponding size reamer tool (FIGS. 11, 12, and 13) is selected and attached to the reamer handle (FIG. 10) using the special tool (FIG. 14). The rounded tip 50 (FIG. 10) is then located in the pilot hole and the glenoid is symmetrically reamed surrounding the pilot hole. Because the glenoid component of the invention is longer in the superior-inferior direction than in the anterior posterior-direction, and because the reamer is circular, a superior portion of the glenoid is removed with a high speed burr after the reaming step is completed.

**[0042]** A correspondingly sized keel drill guide (FIGS. 15-17) is then chosen. The guide post 76 is placed in the pilot hole and the guide holes 73, 75, 77 are used to drill three holes which have axes aligned in a plane which is anteriorly offset from the pilot hole. A correspondingly sized broach tool (FIGS. 18 and 19) is then chosen and is used to connect the three holes and form a triangular or trapezoidal cavity for the keel. A correspondingly sized glenoid component (FIGS. 1-4) is then installed with bone cement covering the keel and the medial surface and is placed to tilt slightly downward (up to approximately 5 degrees) in order to reduce superior migration of the humeral head. The angular alignment of the glenoid component may be facilitated by using radiopaque material (such as radiopaque wire(s)) in the two small holes in the keel and viewing placement fluoroscopically.

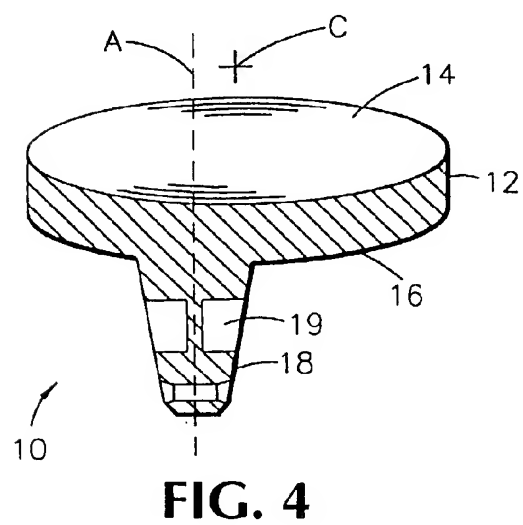
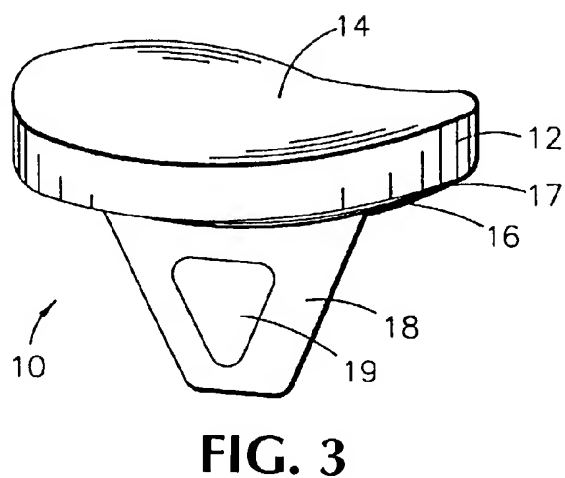
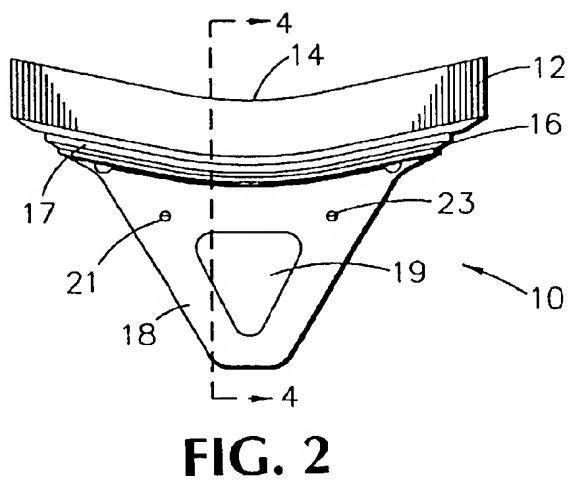
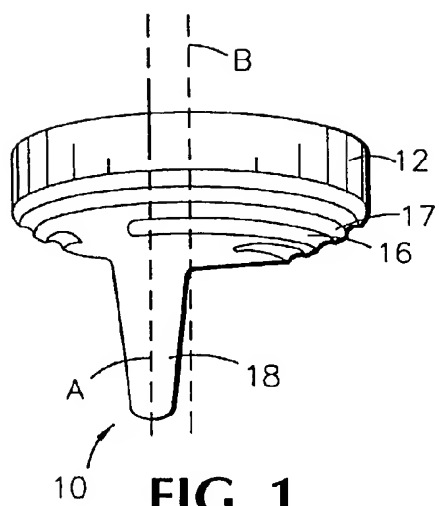
**[0043]** There have been described and illustrated herein a glenoid component and methods and apparatus for implanting the glenoid component. While particular embodiments of the invention have been described, it is not intended that the invention be limited thereto, as

it is intended that the invention be as broad in scope as the art will allow and that the specification be read likewise. It will therefore be appreciated by those skilled in the art that yet other modifications could be made to the provided invention without deviating from its spirit and scope as so claimed.

## Claims

1. A prosthetic glenoid component 10, comprising a body 12 having a concave lateral surface 14 and an opposed medial surface 16 with a keel 18 extending from the medial surface, said concave lateral surface being defined by one or more radii, said keel 18 lying in a plane which is anteriorly offset from the center of said body and said plane lying non-collinear relative to each of said one or more radii.
2. A glenoid component according to claim 1 wherein said body 12 is substantially oval.
3. A glenoid component according to claim 1 wherein said medial surface 16 is provided with a plurality of ridges 17.
4. A glenoid component according to claim 1 wherein said keel 18 has at least one recessed pocket 19.
5. A glenoid component according to claim 1 wherein said keel 18 has a pair of spaced apart holes 21, 23 for receiving radiopaque material, said spaced apart holes defining an axis parallel to the vertical axis of said component.
6. A glenoid component according to claim 1 wherein said plane is approximately 2mm anterior of the center of said body 12.
7. A glenoid component according to claim 1 wherein said keel 18 is substantially triangular in shape.
8. A glenoid component according to claim 1 wherein said keel 18 is substantially trapezoidal in shape.
9. A sizer drill guide 20 for locating a pilot hole in the glenoid of a scapula during a prosthetic glenoid implantation procedure, said sizer guide comprising:
  - (a) a handle portion 22 having a distal end;
  - (b) a drill template portion 24 coupled to said distal end, said drill template portion having a through hole 25; and
  - (c) an alignment arm 28 for automatically aligning the angle of the through hole 25 relative to the scapula.

10. A drill guide according to claim 9 wherein said alignment arm 28 forms an angle of approximately 65 degrees with the axis of said through hole 25.
11. A drill guide according to claim 9 wherein said alignment arm 28 is removably attached to said handle portion 22.
12. A glenoid reamer for resecting a portion of the glenoid of a scapula during a prosthetic glenoid implantation procedure, said reamer comprising;
- (a) a handle portion 40 bearing a rotatable shaft 48, said rotatable shaft 48 having a threaded distal end; and
  - (b) a removable reaming head 54 having an abrasive surface and a threaded central through bore 56, said reaming head being removably threadably coupled to said threaded distal end of said shaft 48.
13. A glenoid reamer tool kit for resecting a portion of the glenoid of a scapula during a prosthetic glenoid implantation procedure, said kit comprising:
- (a) a handle portion 40 bearing a rotatable shaft 48, said rotatable shaft having a threaded distal end 52; and
  - (b) a plurality of different size removable reaming heads, each having an abrasive surface and a threaded central through bore 56, each of said reaming heads being removably threadably coupled to said threaded distal end of said shaft.
14. A kit according to claim 13 wherein each of said reaming heads has a plurality of angularly spaced apart through slots 60.
15. A kit according to claim 14 further comprising a reaming head wrench 62, said wrench having a plurality of angularly spaced apart through slot engaging members 64.
16. A keel drill guide 70 for use in a prosthetic glenoid implantation procedure for implanting a glenoid component having a medially extending keel 18 which is anteriorly offset from the center of the glenoid component, said keel drill guide comprising:
- (a) a handle portion 72 having a distal end, and
  - (b) a drill template portion 74 coupled to said distal end, said drill template portion having at least one through hole 73,75,77 which is anteriorly offset from the center of said template portion.
17. A keel drill guide 70 according to claim 16 wherein said drill template portion 74 has a plurality of through holes 73,75,77, each through hole having an axis, said axes lying in a common plane which is anteriorly offset from the center of said template portion.
18. A keel drill guide 70 according to claim 16 further comprising a guide post 76 extending distally from said drill template portion 74.
19. A keel drill guide 70 according to claim 18 wherein said guide post 76 is located in the center of said drill template portion 74.
20. A keel drill guide 70 according to claim 17 wherein said plurality of through holes 73,75,77 comprises three parallel through holes.
21. A broach tool 80 for use in a prosthetic glenoid implantation procedure for implanting a glenoid component having a medially extending tapered keel, said broach tool comprising:
- (a) a handle portion 82 having a distal end; and
  - (b) a base 84 coupled to said distal end, said base portion having a distally extending tapered rasp 86.
22. A broach tool 80 according to claim 21 wherein said tapered rasp 86 is anteriorly offset from the center of said base portion.
23. A broach tool 80 according to claim 21 wherein said tapered rasp 86 has a substantially triangular profile.
24. A broach tool 80 according to claim 21 wherein said tapered rasp 86 has a substantially trapezoidal profile.



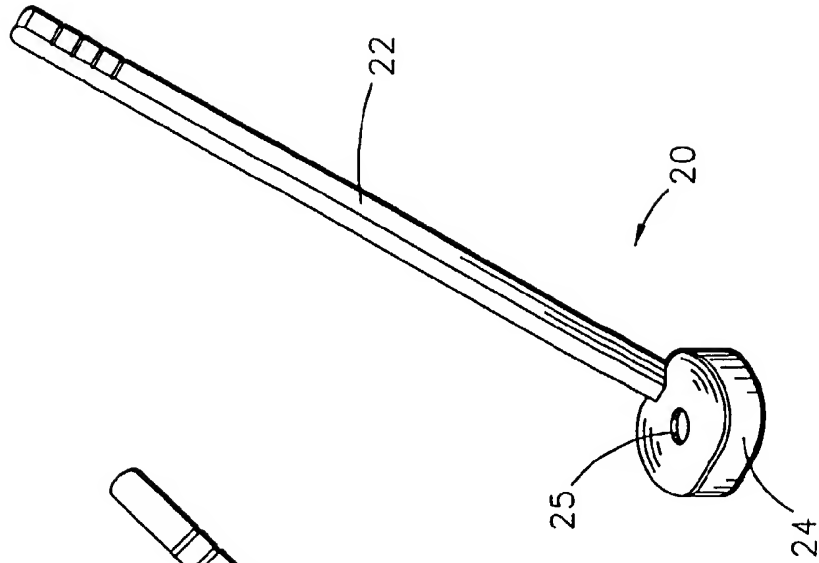


FIG. 7

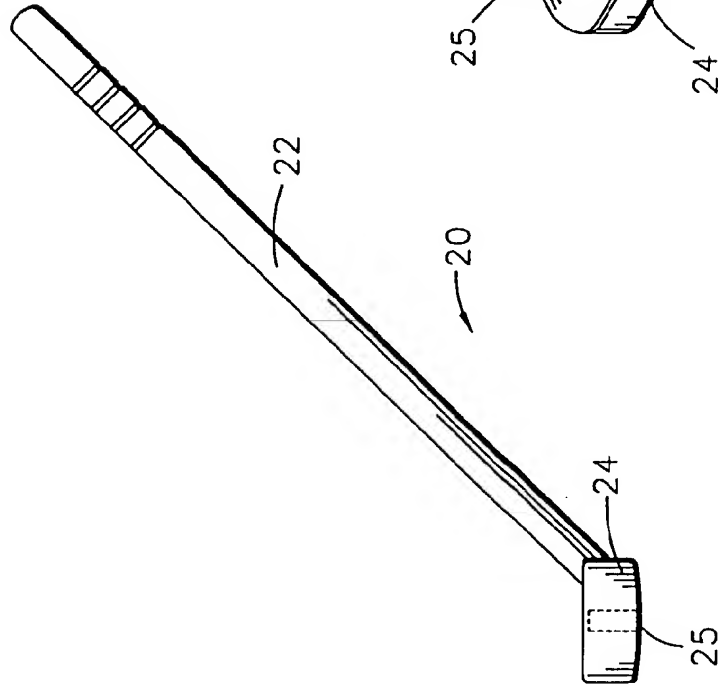


FIG. 6

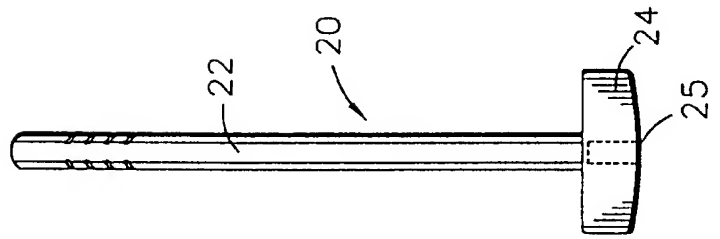


FIG. 5



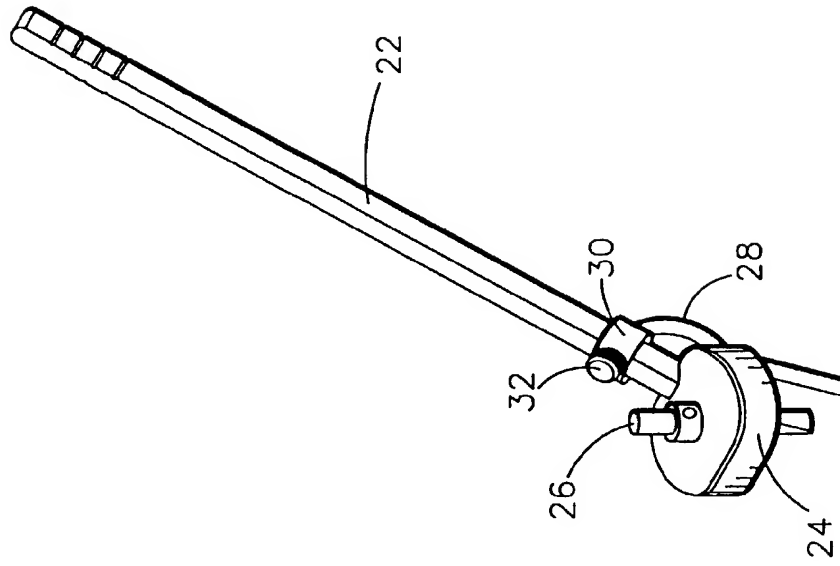


FIG. 9

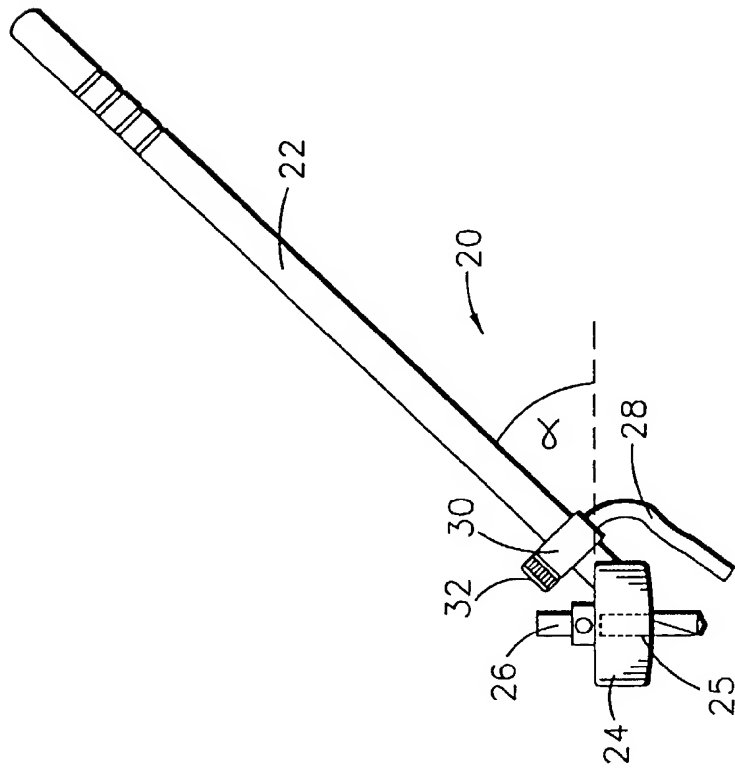
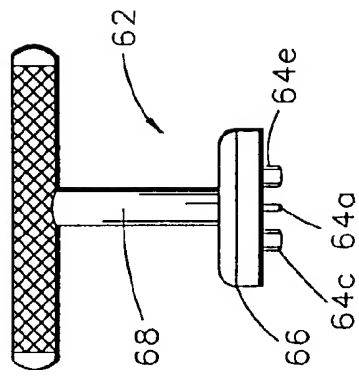
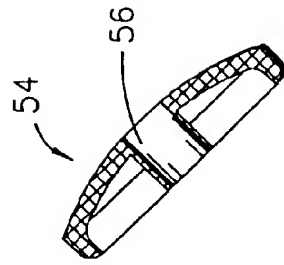


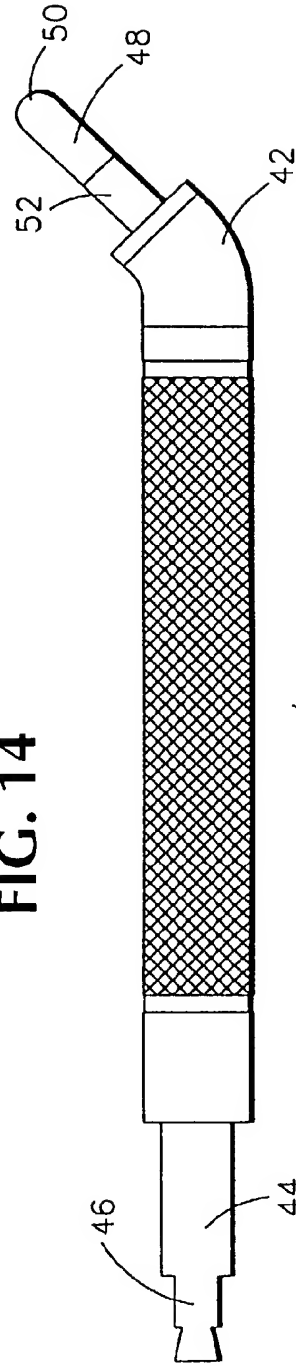
FIG. 8



**FIG. 13**



**FIG. 14**



**FIG. 10**

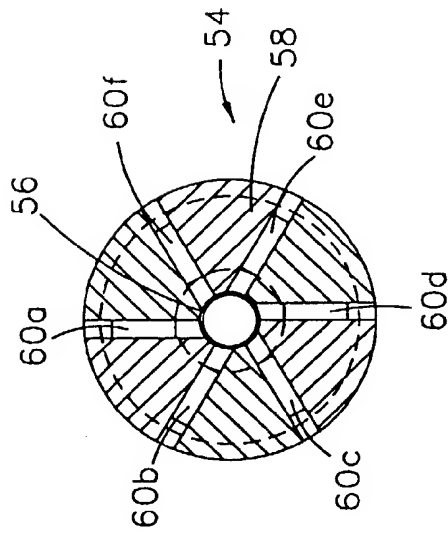


FIG. 12

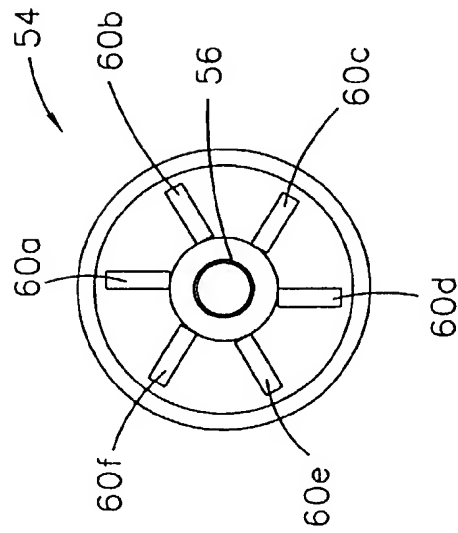


FIG. 11

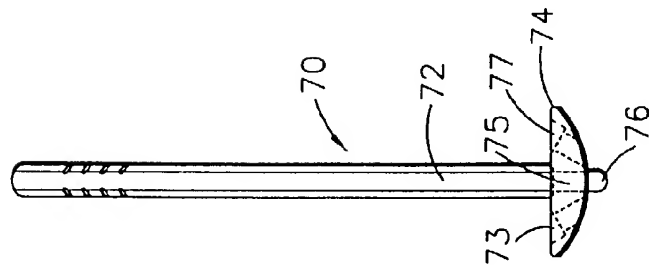


FIG. 15

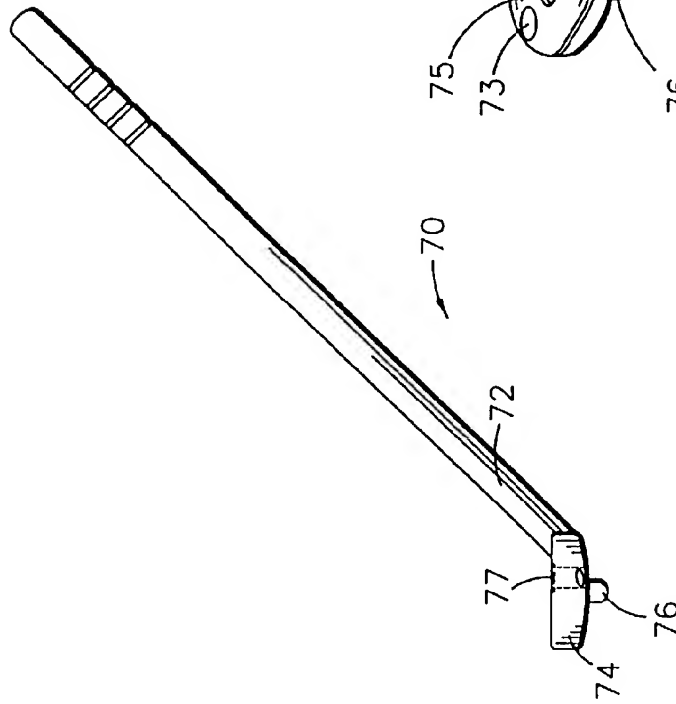


FIG. 16

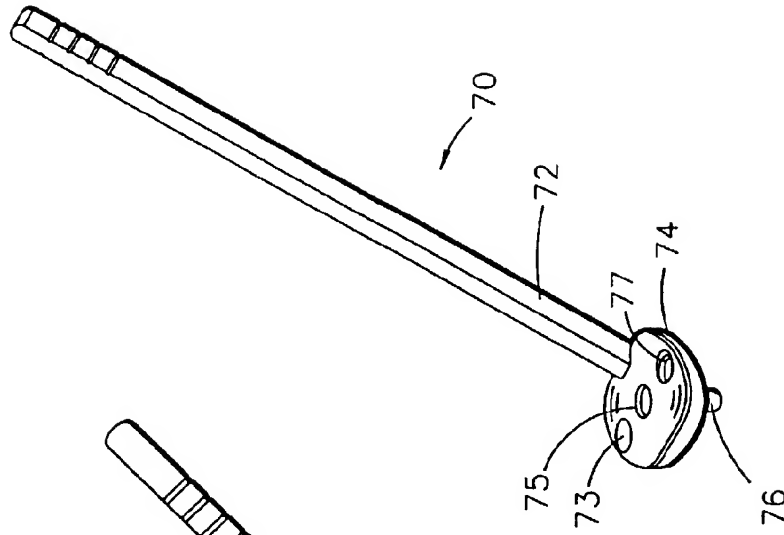


FIG. 17

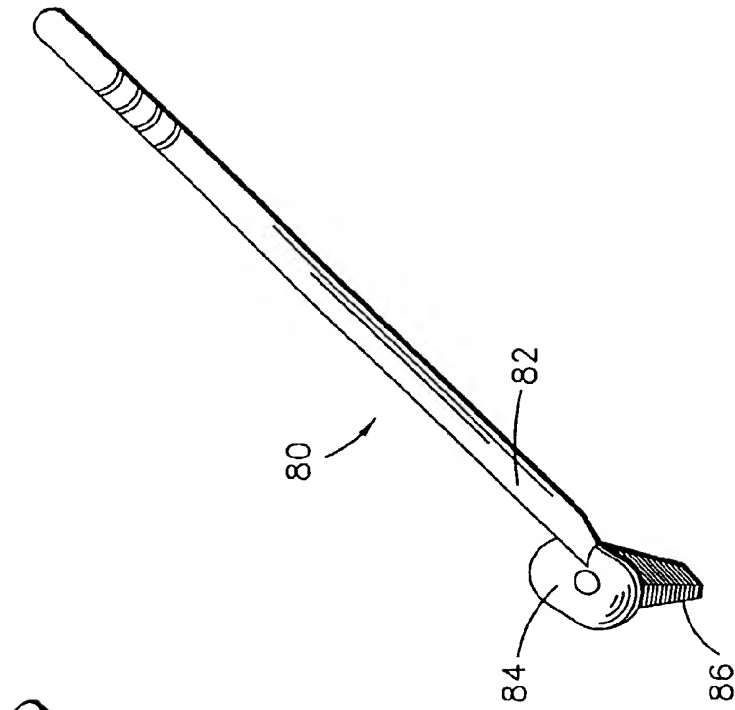


FIG. 18

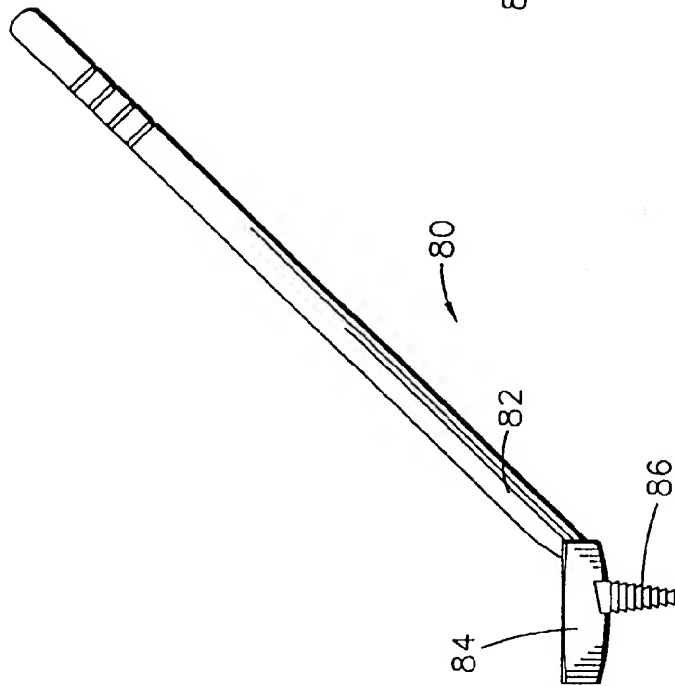


FIG. 19